Katzman, Martin T., *Chemical Catastrophes and the Courts* , Public Interest, 82 (1986:Winter)
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Chemical catastrophes and the courts

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BHOPAL, Times Beach, Agent Orange. Hardly a week passes without a news story about some community disaster traced to human exposure to a hazardous substance, with the latest culprit invariably described as the "the most toxic chemical known to mankind." In the issue-attention cycle of American politics, toxic chemicals are surely in the ascendancy. Political entrepreneurs eagerly seize upon the issue of protecting their constituents from chemical assault. Meanwhile, Bhopal is compared to Three Mile Island, and the dump sites scattered in thousands of places around the nation are described as "chemical time bombs."

What is the nature of chemical risks? How do they differ from other natural and man-made risks? What policy instruments does society possess to cope with chemical risks in a reasonable way? Is there an easy fix?

The nature of chemical risks

The rise of chemical risks is often traced to the rapid growth of the synthetic chemical industry in the past forty years. In addition to putting naturally occurring minerals to new uses (for example, using asbestos as a fire retardant), industry has generated a cornucopia of new compounds not previously found in nature. The number of synthetic chemicals in the repertoire of industrial societies now exceeds 4 million, although only about 55,000 are in common use.

With the exception of a few chemicals developed for warfare, like Agent Orange, most synthetic chemicals have been developed for benevolent uses. Unfortunately, some of these chemicals prove to be dangerous either at common levels of exposure, or in combination with some other apparently harmless chemical. The list of useful substances with potentially hazardous side-effects includes the fire-retardant Tris and electrical insulator PCBs. When hazardous side-effects are discovered, a safer substitute can usually be developed, but not always.

Until the accident in Bhopal, public attention to chemical hazards in the environment focused upon waste disposal, the end of the "chemical life cycle." Bhopal showed that human exposure to hazards can occur at many points in the chemical life cycle. Workers may be exposed during the manufacture of the primary chemical from raw materials, during the fabrication of a consumer product, or in the use of the chemical in, say, insulating roofs with asbestos tile. Consumers may be exposed through their use of the chemical in the home. The public may be exposed at any stage in the cycle, as chemicals may escape into the air, the surface water, or groundwater. For example, the methyl isocyanate that injured the residents of Bhopal was an intermediate product in the manufacture of a common insecticide that is rendered relatively harmless to humans after a few days in the field. Similarly, the dioxins to which the residents of Times Beach, Missouri were exposed, were also a waste product.

While the volume of synthetic chemicals in use has multiplied dramatically, human exposures to significant chemical hazards in the environment probably have not. The vision of a modern society increasingly poisoning its environment is difficult to reconcile with the fact of dramatic improvement in life expectancy in the past decade. The incidence of cancer is generally taken as the barometer of toxicity. While carcinogenesis may take decades, synthetics have been used long enough so that major increases in its incidence would have been observed by now. In fact, the age-specific incidence of cancers has remained remarkably stable. Because cancer appears to be a function of aging, the increasing proportion of deaths attributable to cancer probably results from our increasing life span.

Another fact that puts synthetic chemical hazards in perspective is the ubiquity of natural carcinogens. While regulators are generally concerned with protecting the public from exposures measured in parts per million or parts per billion, we routinely consume parts per thousand of carcinogens in such mundane comestibles as peanut butter and well-done steak. Epidemiologists trace about 25 percent of all cancers to man-made environmental and occupational exposures, and the rest to voluntary consumption of foods, drugs, and stimulants, and to naturally-occurring carcinogens.

There is nothing irrational about the public preoccupation with risks of dioxin rather than risks of peanut butter. Chemical hazards in the environment are obviously different from familiar, commonplace hazards. We have chosen to worry about demons which are imposed by the actions of others, which may lead to mass disaster, and which may have irreversible or intergenerational effects—concerns common to materially-advanced societies worldwide.

Voluntary and involuntary risks

When potential victims are knowledgeable, it is not difficult to achieve acceptable levels of voluntarily-borne chemical risks. Where two parties have a contractual relationship, this may be achieved by informed bargaining—for example, in the workplace. In the past, many companies kept the characteristics of chemical hazards a "trade secret," so that worker consent was not "informed." Recent "right to know" legislation has changed all that. So have labor unions, which have accumulated expertise in assessing the hazards faced by their members. Employers offering risky jobs may now be faced with exceptionally high employee turnover, may have to offer "combat pay" to retain the labor force, or may have to pay high Workers' Compensation premiums.

In the case of consumer products, agreeing on what constitutes acceptable risk is more difficult. For example, upon weighing the risks against the benefits, an individual may choose to smoke, to put saccharine in his coffee, or to spray his garden with chlordane. The dispute over saccharine suggests that we do not readily consent to paternalism when we feel informed and competent. Yet because we are exposed to so many chemicals embodied in products, it is almost impossible to make informed judgments about all of them. Such exposures can be viewed as involuntary, and it is reasonable for us to delegate decisions about acceptable exposures to consumer products to a governmental agency. The argument applies *a fortiori* to involuntary exposures to chemicals in the environment.

Bhopal and Love Canal, of course, are examples of involuntary chemical exposures. Without question, the public is far less tolerant of involuntary risks than of voluntary risks of similar magnitude. The search for institutions to regulate or manage involuntary risks must be guided by two considerations: efficiency and fairness.

Efficiency means minimizing the total of the cost of accidents plus the cost of preventing accidents. This does not lead to a policy of zero risk. In traditional theories of negligence (articulated as Judge Learned Hand's rule), reasonable risk management is achieved when the cost of additional expenditures on safety just offset the change in the probability of an accident multiplied by its severity. For example, under the common negligence rule, a hazardous waste dump operator is not expected to spend an additional $1 million to lower the probability of a $10 million accident by one chance in a thousand. If the operator declined to spend $1 million and reduce the probability of an accident by one-half, then he would be held negligent and liable for damages. Encouraging cost-effective deterrence, this common law rule bears an obvious relation to economic rules of optimality.

Efficient deterrence may conflict with fairness or equity. Suppose the victim of a rare event, in a case in which the polluter is not negligent, does not recover damages. Since the victim was innocent and unknowing, the outcome appears to be unfair. Moreover, the cost of this accident is not reflected in the cost of the polluter's product. For rare accidents, like chemical injuries, reconciling efficient deterrence and just compensation is not easy.

There are three mechanisms for managing risks: tort law, statutory regulation, and economic incentives. All can contribute to regulating chemical hazards, but none provides a panacea.

Toxic torts

Common law is a traditional mechanism for recovering damages. Victims can seek redress for injuries under various theories, such as nuisance, trespass, or negligence. Regardless of the theory, there are several steps that the victim or plaintiff must take: the suit must be filed within the statutes of limitations; a specific defendant or defendants must be identified; and the victim must prove a causal connection between the defendant's behavior and the plaintiff's injury. The alleged polluter may defend himself by arguing that the plaintiff's behavior was crucially responsible for the injury. The plaintiff may have come to the nuisance (for example, by moving into the Love Canal neighborhood in the first place), by contributory negligence (trying to pick up a housing "bargain" now that Love Canal has been deemed safe), or by neglecting to take reasonable avertive behavior.

For normal mechanical injuries, these rules have proven to be workable. For example, if a pedestrian is struck by a car, the injury is immediately apparent. Usually, the courts can determine the cause of the accident and can apportion liability in some reasonable manner. Questioning the plaintiff's contributory behavior (did he jaywalk?) is reasonable if the victim could have avoided the injury easily and cheaply.

Chemical injuries pose more difficult problems of regulation and risk management through the tort process than those from common "mechanical" technologies. Indeed, the traditional system breaks down because of the unique character of chemical hazards.

First, a statute of limitations prevents the filing of a suit after a short period, three to five years, after an accident. Many toxic chemicals, however, persist in the environment; that is, they do not break down easily into harmless substances. A chemical may gradually seep into the groundwater or may become concentrated as it works its way through the food chain. As a result, the time of a spill or a release may precede the time of human exposure by many years. Second, for some toxic chemicals, particularly carcinogens, the time of human exposure may precede the manifestation of injury by several decades. For these two reasons, conventional statutes of limitations provide insuperable barriers to recovery.

Third, there are multiple pathways through which a given chemical may affect humans. Where the exposure occurs determines whether the victim can seek a remedy through the Workers' Compensation system, through a product liability suit, or through appeal to environmental protection statutes. Even if the locale of exposure were identified, it may be practically impossible to identify the defendant whose molecule caused the plaintiff's injury. This is clearly the case of exposures from hazardous waste sites, where many companies discard identical chemicals.

In order to prove causation in toxic torts, the plaintiff must establish the following facts: there was a hazardous condition; the defendant's conduct resulted in this condition; the plaintiff was exposed to this condition; the plaintiff suffered a demonstrable injury; and there was a proximate causal connection between the exposure and the injury. Proof of causation depends upon presenting sophisticated biomedical evidence, most of which is indirect or analogous in nature. Because toxicologists are uncertain about long-term human responses to low, intermittent doses of chemicals, such evidence is rarely conclusive.

The major barrier to recovery in toxic tort litigation is the cost of establishing causation. The cost of the necessary scientific testimony may exceed the damages recovered. The plaintiff may thus be unwilling to file a suit. The costs of litigation might be spread by aggregating similar claims. Aggregation through a class action is generally possible when all plaintiffs have suffered nearly identical injuries from the same accident, such as an airplane crash. Because exposures to hazardous chemicals may occur discontinuously over a long period of time and because victims' symptoms differ, courts are reluctant to certify toxic torts as class actions.

Caution in the courts

The courts have responded reasonably to the inability of the traditional common law to deal with toxic torts. In the past decade, changes in toxic tort law, related to changes in product liability law, have been nothing less than revolutionary. This revolution has proceeded at an uneven pace from state to state. In some states barriers to recovery in toxic tort actions have also been reduced by statute.

About three-quarters of the states have solved the problem of statutes of limitations by adopting a "discovery rule." Under such a rule, the legal "time clock" begins not with the exposure but with the manifestation of injury. Eight state legislatures, however, have reaffirmed the traditional statute of limitations, which begins at the time of the alleged exposure. In such states, recovery for long-latent damages is almost impossible.

Identifying a defendant liable for a specific chemical exposure in the environment is more difficult than identifying, for example, which pharmaceutical company manufactured the tranquilizer taken by the pregnant mother (that eventually resulted in the daughter's cervical cancer), or which asbestos manufacturer supplied a fiberboard installer with the hazardous raw material. Landmark cases in the areas of pharmaceuticals and asbestos have resulted in the adoption of rules of joint and several liability in most states. While there are several alternative rules, in essence they hold that a defendant who was remotely connected with a hazardous chemical may be held liable for a share of the damages. If other parties are unidentifiable, or bankrupt, then this defendant may be held liable for all the damages. This rule of apportioning blame among defendants increases the probability that *someone* pays for environmental risks imposed upon third parties. While this rule serves the victims well, it can be counterproductive. By making a firm "its brother's keeper," the costs of poor waste-handling practices are spread to other firms, and incentives for deterrence are attenuated. Obviously, if joint and several liability are viewed as a search for the "deepest pocket," the objectives of optimal deterrence and fair compensation may conflict.

The application of theories of joint and several liability is yielding some interesting consequences. For one thing, it raises the likelihood of insurers paying claims against clients that resulted from damages caused *not* by their clients (whose facilities they have inspected and analyzed), but by other firms. Insurers have little way of assessing such risks. One response is the establishment of voluntary clean-up efforts by the chemical industry, which appear more effective and speedier than federal efforts under the Environmental Protection Agency's Superfund. Second, many waste-handlers now favor the establishment of standards of care through regulation. Tough regulations reduce the chances of a responsible firm's (and its insurer's) having to pay the bills for a careless competitor. Insurers like tougher regulations on chemical handlers because claims cannot be made for accidents caused by behavior that violates regulations.

The major remaining barrier to recovery in toxic tort litigation is the cost of obtaining scientific testimony. In response, plaintiffs' lawyers have developed new techniques of mass disaster litigation. Under a "group action," a single attorney acts as trustee for a defined group of individuals who allegedly suffered damage from the same cause, but not necessarily at the same time or with the same injury. Joining the group for a fixed fee, each plaintiff retains his own counsel, who may meet regularly with his counterparts. The trustee operates as a central clearinghouse for dispatching a background package of data containing sample pleadings, answered interrogatories, medical articles, governmental publications, and newsletters. Most important, common expert testimony on discovery and scientific causation can be submitted as a deposition in each plaintiff's own jurisdiction. While a significant factor in reducing the costs of litigation, group actions can only present scientific evidence that is as good as the state of the art—which is modest at best.

In the face of scientific uncertainties and conflicting expert testimony, some courts may put to one side complex, technical data and assumptions. The court may ignore the problems of isolating the harm-causing substance, tracing the pathway from the polluter to the plaintiff, and showing the etiology of the disease. Instead, it may simply ask whether it is more likely than not that the plaintiffs suffered a particular injury as a result of presumed exposure to the defendant's chemical hazard.

Such a court is amenable to evidence of whether the incidence of the injury, say a particular tumor, in a population exposed to the hazard is at least twice as high as the incidence in a similar, unexposed population. Suppose, for example, there is normally one tumor per 10,000, but among the plaintiffs, the incidence is three tumors per 10,000. The court may reason that there is more than a 50 percent chance (the odds are two to one) that the plaintiffs' injuries were caused by the hazard. Clearly, the court cannot identify the one in 10,000 who would have incurred the tumor, so the rule may result in overcompensation. If one accepts the Rawlsian "veil of ignorance" as a reasonable premise (no victim knows whether he would have had the tumor anyway), the result is not necessarily unjust to the plaintiffs.

Can statutes fill the gap?

Despite the improvements in procedures for recovering from toxic torts, there are significant gaps which make the achievement of acceptable risk through the tort process improbable. Winning in court does not necessarily guarantee recovery. The mortality of businesses is often higher than the mortality of their victims. In several cases, the polluting business has been dissolved or declared itself bankrupt, and the victim has been unable to recover damages. Furthermore, losses to victims may exceed the liquid assets or net worth of corporations.

Because of time lags, losses to victims in the distant future do not inevitably translate into losses to corporations at the time when risk management decisions are made. In a corporate environment where the rewards for risk managers are based upon minimizing the current costs of accidents plus accident prevention, the cost of future accidents may be given short shrift.

The imperfections in the tort process and the attenuated incentives for business risk management render asymmetric the distribution of benefits and risks from chemical technologies. Generally, the public finds least acceptable those risks which are asymmetric. Clearly, this characteristic, among others, helps explain the widespread public dread of chemicals in the environment.

Because of the perceived inability of the tort law to regulate chemical hazards sufficiently, Congress passed several acts in the past decade. The bills of the early 1970s, like the Clean Water Act and the Clean Air Act, enable the EPA to establish permissible levels of discharge or emission of hazardous pollutants. These levels are supposedly established at concentrations that have "acceptable" consequences on human morbidity and mortality. For example, a business can intentionally and knowingly emit up to ten parts per million of the carcinogen vinyl chloride into the air. In practice, standards have been established for only a handful of substances. By their nature, these statutes can have little impact on regulating human exposures to *unforeseen* chemical hazards.

Another early standard-setting statute, the Safe Drinking Water Act, mandates the monitoring and testing of public water systems. The act is aimed chiefly at the large number of small-scale, proprietary water systems, which are often operated with minimal testing of impurities. Operators of water systems are expected to eliminate contaminants that are above the approved concentrations, but relatively few standards have actually been set. The act has virtually no provisions for deterring the behavior that results in the contamination of these water supplies.

The Toxic Substances Control Act (TOSCA) offers greater potential for regulating exposures to risks throughout the chemical life cycle. It provides procedures for assessing the risks of both new and existing chemicals. Chemical manufacturers must provide the EPA with a pre-manufacturing notification (PMN) for any proposed new chemical or expanded use of an existing chemical. This notification must include a description of the proposed volumes and uses of the chemical as well as a preliminary analysis of the toxicity to humans at exposures likely to be encountered during the chemical's life cycle. On the basis of the PMN, the EPA can approve or reject the chemical, or require further testing.

While the EPA has required additional testing on only a handful of chemicals and has rejected only one, the proximate effects of the PMN requirements appear dramatic. The number of new chemicals introduced annually has dropped from about 2,000 to about 700. Whether these effects are beneficial is not clear. Perhaps many of the 1,300 chemicals that were not introduced would have yielded benefits far in excess of their risk. If so, then why were they not introduced? The reason is that the cost of preparing a PMN is estimated at about $25,000. This sum appears small, but in fact absorbs a substantial proportion of the expected profits of many small-volume specialty chemicals.

TOSCA also mandates the assessment of the 50,000 chemicals in current commerce that appear most risky. The burden of assessment is on government. TOSCA provides manufacturers with no incentives for performing risk analysis, or for discarding risky chemicals from their product line. The testing program has proceeded at a sluggish pace.

The Resource Conservation and Recovery Act (RCRA) of 1976 and the "Superfund" Act of 1980 focus on the "back end" of the

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chemical life cycle; that is, disposal. RCRA establishes a "cradle to grave" system which records shipments from the disposing firm to the ultimate waste site. RCRA also authorizes the EPA to establish technological specifications for hazardous waste site operators. Together, these provisions raise the cost of disposing of chemicals. Rising disposal costs can encourage recycling or recovery of waste chemicals or discourage the use of the hazardous chemical in the first place. If fully implemented, RCRA should reduce the probability of the "midnight dumping" of hazardous substances, as occurred, for example, in Times Beach.

The traditional proscriptions and prescriptions of these statutes serve a limited deterrent function. In essence, the strictures establish levels of exposure to hazardous substances that are "acceptable" under the statutes, but are unlikely to reduce the risks of accidents like Bhopal. Only Superfund copes with the consequences of accidents, but it ignores victim compensation.

The turn to incentives

Superfund makes less use of traditional strictures and a broader use of economic incentives than any other environmental statute. Three economic incentives in the act reflect the spirit of market-oriented regulation.

Superfund imposes a tax on the tonnage production of a specified list of petroleum and chemical products. These tax revenues are dedicated to a fund for financing the emergency response to chemical spills at all stages of the life cycle and for clean-up of abandoned hazardous waste sites. Another tax is levied on tonnage disposed at hazardous sites. These revenues are dedicated to a federal fund for monitoring and operating waste sites that have completed their life cycles.

A tax on the production of chemicals is a crudely-honed incentive. This tax presumes that the production of chemicals *per se* imposes risks on society that may be realized somewhere in the chemical life cycle, and that the tax rate should vary with the presumed hazardous classification of the chemical. The production tax does not distinguish between careful and careless businesses. Similarly, the disposal tax does not distinguish between waste sites that are perilously close to municipal water supplies and those which are not. Nevertheless, in the absence of credible risk analysis, tonnage of production and disposal may be a workable surrogate for chemical risk.

The third, and perhaps the most important, economic incentive is the "financial responsibility" requirement. Both Superfund and

RCRA require disposers of hazardous chemicals to demonstrate that they are financially capable of coping with the consequences of third-party chemical injuries. Superfund extends this requirement to transporters and to facilities generating hazardous waste. Both acts favor, but do not require, the purchase of insurance for pollution damages. Large businesses that can meet a test of financial strength do not have to purchase insurance.

If properly structured, financial responsibility requirements can bridge the gap between private risk management behavior and socially acceptable behavior and can also reconcile the compensation and deterrence objectives of social risk management. Proper structuring includes setting the limits of financial responsibility near the upward tail of the distribution of damages. Congress currently sets the limits at $3 million per occurrence with a $6 million annual aggregate for disposal sites. The association of state insurance regulators believes these limits are too low. With the help of the insurance industry, limits for waste-generating facilities will be fixed by the end of the decade.

Moreover, the expected value of future damages from current operations should be reflected in current expenses. That is, the risks a company poses to the public should be reflected on its income statement and balance sheet now.

In theory, these simple principles will encourage the adoption of cost-effective risk-reduction practices. Suppose a chemical company's pollution insurance premiums were based upon the expected frequency and severity of damages. The company would then have an incentive to undertake risk-control measures that cost less than the premium savings. The everyday analogy is a reduction in insurance premiums for the nonsmoker or safe driver.

It is interesting that the implementation of both RCRA and Superfund relies upon an insurance mechanism that was poorly developed at the time of their passage. The acts presumed that pollution liabilities are insurable.

Traditionally, insurable exposures have several well-defined characteristics: they are homogeneous and numerous enough to allow risk pooling; the loss must occur in a well-defined time period; and the chance and magnitude of loss must be calculable. Gradual pollution accidents have none of these characteristics. As a result, the insurance industry has had some difficulty in developing policies.

While there are tens of thousands of hazardous waste sites and generators, the demand for pollution liability insurance has been small. Only waste handlers and transporters come under the financial responsibility requirements. In Texas, for example, only about one-quarter of waste disposers large enough to meet the test of financial strength also purchase insurance. Because financial responsibility requirements were phased in over several years, small firms did not have to meet financial responsibility requirements until this year. Of the firms that do insure, very few purchase more than the statutory minimum.

Unlike commonplace accidents—for example, fires—events like the leak of an underground chemical tank are quite difficult to pinpoint. If a house burns down in 1984, the insurer that issued the homeowner's policy in that year must indemnify the victim even if the claim is filed in the following year. By contrast, the actual corrosion of a tank may have taken several years, while the leaking to the groundwater may have taken a decade. The tank owner may have switched insurance companies many times in the interim. Under the traditional insurance policy, which is activated by the occurrence of the accident, it is almost impossible to determine *which* insurer is responsible for indemnifying the tank owner for his liabilities.

Because chemical disasters are such rare events, the computation of rates on the basis of loss experience is nearly impossible. Even if loss data were available, they would reflect outmoded safety technologies that are no longer in currency. Furthermore, insurers have little knowledge of the risk reduction technologies available to the insured. Consequently, they are unable to offer premiums that are proportional to the risks.

The insurability problems have proven difficult but not insoluble. Beginning in the late 1970s, several members of Lloyd's of London began offering pollution liability insurance. In the 1980s, a few American firms entered the market with the backing of the large London "reinsurers," who participate in part of the risk.

Pollution policies have been tailored to the unique characteristics of chemical hazards. While policies differ among companies in their exclusions and coverage, they are all claims-made policies, with a specified retroactive date. For example, a chemical company may wish to insure against claims filed in 1985 for accidents that may have originated in 1910, the date of the company's founding.

Premium-setting has proven difficult. One frank underwriter told the author, "We have no data, no actuarial table, no cookbook policy. Insurers are supposed to be professionals selling products of substance and integrity, not just guesswork. Prices for risks are by gosh and by darn, and what the market will bear."

In practice, the insurers have seriously misjudged the risks. The difficulties in anticipating the behavior of the courts has only amplified the difficulties inherent in chemical risk analysis. Last year, London reinsurers had to pay five times as much as they have collected in world-wide pollution liability premiums in the past four years. The reinsurers began withdrawing from the market in late 1984, and the number of American pollution insurers has shrunk to about eight. Most insure "light risks" like gas stations and dry cleaning establishments. Only two insure the "heavy" risks, from which catastrophes are most likely to result.

Why not increase insurance premiums by a factor of five or more until they surpass the break-even point? The reason is "adverse selection." Higher premiums will encourage firms that believe they face few risks to self-insure. This exodus leaves the insurers with the riskier exposures. The ratio of losses to premiums then rises, the industry raises its premiums, driving additional firms into self-insurance, *ad infinitum*.

Deterrence vs. compensation

Clearly, it is difficult to establish any workable mechanism for regulating chemical risk. As currently developed, none of the three regulatory mechanisms—tort law, statutes, or economic incentives—adequately deals with both the deterrence and compensation objectives of public policy. The brief experience with pollution liability insurance suggests that market mechanisms for managing risks are not easily established.

The real problem is that no one, neither insurers nor EPA regulators, knows how to analyze chemical risks in a credible manner. Low risks are inherently poorly-estimated and ambiguous. Furthermore, there are well-known biases in the estimate of such risks. The public tends to overestimate the likelihood of catastrophes, while technological experts systematically underestimate the likelihood. Incentive structures create differences between risk analysts in the insurance industry and risk analysts in government. If insurers underestimate risks in premium setting, they suffer financial losses. If they overestimate risks, then their product will be overpriced compared to competitors. In contrast, government risk analysts are penalized if unlikely accidents happen, but they are not penalized for setting standards too high. Without credible risk analysis, what can be done?

One approach is to separate the problems of deterrence and victim compensation. The no-fault Workers' Compensation system exemplifies this approach. This system is based upon "rebuttable presumptions" of causality that lessen the burden of proof and expedite compensation.

A congressionally-mandated study suggested the creation of a two-tier compensation mechanism for toxic injuries. Tier One consists of the new toxic tort law, with the formidable barriers to recovery balanced against the potential for large awards for pain, suffering, and other damages. Tier Two consists of an administrative system for reimbursing medical payments and lost wages. Because of the lesser burden of proof, Tier Two would offer recovery to a larger number of victims than Tier One, but at a considerably lower level of compensation. The compensation fund would be financed by a tax on the production of chemicals, just like the clean-up activities of Superfund.

When Superfund was passed, victim compensation schemes like Tier Two were defeated. Opponents saw the attenuated burden of proof as offering an open-ended entitlement. Citing the experience of the Black Lung Fund for miners, opponents saw no grounds for excluding anyone with the remotest claim of injury from exposures to chemicals in the environment.

Three states have established victim compensation funds, and the fears of the opponents have yet to be realized. In California, for example, fewer than half a dozen claims have been filed. As victims become aware of the existence of pollution victim compensation funds, however, Pandora's box might open indeed.

A more fruitful approach to chemical risk management is to develop the three mechanisms described here as a mutually reinforcing tripod. Statutory adjustments can make both the tort process and economic incentives more effective. Financial responsibility requirements can insure that successful plaintiffs will not face a bankrupt defendant. A predictable tort process can make pollution risks more insurable. Economic incentives can make the statutes self-implementing.

The standardization of toxic tort law through federal statute would reduce the legal ambiguities facing the insurers and their clients. Congress should enact a discovery rule and standards of strict liability for third-party personal injury and private property damages, similar to those enacted in nuclear regulation.

In order to serve a regulatory purpose, the pollution liability insurance market must be bolstered on the demand side. Demand could be strengthened by employing restrictions already implemented by several states. These include requiring generators of hazardous chemicals to demonstrate financial responsibility, prohibiting self-insurance, and raising the required minimum insurance levels. Greater demand should facilitate risk pooling and provide insurers with enough claims experience to improve risk analysis.

Compulsory insurance is still no guarantee that private insurers will provide adequate insurance. Nuclear power plants have been required to insure since 1957, when liability limits were set at $500 million per incident. Private insurers were deterred by uncertainty about the risk (there still is little loss data) and the difficulty in risk pooling (the number of plants worldwide is less than 200). Even now, insurers have been willing to provide less than $200 million in coverage, and the remainder of the liability is covered by mutual insurance among plant operators.

Because of the larger number of waste-handling facilities (tens of thousands) and the availability of loss data, greater possibilities for risk pooling exist for chemical than for nuclear risks. Compulsory insurance for chemical pollution may thus be a more workable option. So long as premiums are unregulated, the supply of insurance should be forthcoming. Given the dread of chemicals, the public is likely to resist any pressure from the chemical industry to make pollution liability insurance "affordable" by subsidizing premiums. While no panacea, an expanded pollution insurance mechanism might be the linchpin of an effective chemical risk management system.